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TRAUMA DISORDERS OF THE ARM AND HAND AND
OCCUPATION IN U.S. NAVY ENLISTED PERSONNEL**

**F. C. Garland
C. F. Garland
E. J. Doyle, Jr.
L. Balazs
R. Levine
W. Pugh**

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**NAVAL HEALTH RESEARCH CENTER
P.O. BOX 85122
SAN DIEGO, CALIFORNIA 92186-5122**

**NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND**



**Carpal Tunnel Syndrome and Other Cumulative Trauma
Disorders of the Arm and Hand and Occupation
in U.S. Navy Enlisted Personnel**

Frank C. Garland, Ph.D.¹, Cedric F. Garland, Dr.P.H.²,
Edward J. Doyle, Jr., CAPT, M.C., U.S.N.³, Louis Balazs, M.S.¹,
Richard Levine, B.S.⁴, and William Pugh, M.S.³

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¹Health Sciences and Epidemiology Department
Epidemiology Division
Naval Health Research Center
San Diego, California

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²Department of Community and Family Medicine
University of California, San Diego
La Jolla, California, and
U.S. Public Health Service

³Medical Information Systems and Operations Research Department
Naval Health Research Center
San Diego, California

⁴Department of Mathematics
Cornell University
Ithaca, New York

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Summary

Problem: The majority of reported occupational illnesses in the United States are cumulative trauma disorders of the arm and hand due to repeated motion, vibration, or pressure. Included among these is carpal tunnel syndrome (CTS), which has recently received considerable attention nationally and in the Navy.

Objective: The objectives were to describe demographic factors associated with high rates of CTS and other neuritis of the arm and hand and to identify high-risk Navy occupations for these disorders.

Approach: Computerized records of first hospitalizations of all active-duty Navy enlisted personnel were searched for all cases of CTS, cubital tunnel syndrome, and other neuritis of the arm and hand (ICD-9-CM codes 354.0-354.9) from 1980 to 1988. Age, sex, and race-specific incidence rates of first hospitalization were determined for each disorder, and age-standardized rates were calculated for sex-, race- and occupation-specific groups using the indirect method with the entire active-duty Navy population as the standard.

Results: There were 1,039 first hospitalizations for all neuritis of the arm and hand in 4,095,708 person-years in men and 186 in 365,668 person-years in women, including 583 cases of CTS. Incidence rates of hospitalized CTS rose with age in both sexes. Rates in white women were about triple those in white men ($p < 0.0001$), but rates in black women were not significantly different from those in black men. Rates of cubital tunnel syndrome also increased with age in both sexes, and rates were higher in white women than white men ($p < 0.05$).

In men, occupations with significantly high Standardized Incidence Ratios SIRs ($p < 0.05$) for CTS included aviation support equipment technician, engineman, hull maintenance technician, boatswain's mate, and machinist's mate. In women high risk occupations included boatswain's mate, engineman, hospital corpsman, ocean systems technician, and personnelman. Several occupations in each sex had significantly high SIRs for cubital tunnel syndrome, with high rates in hospital corpsmen of both sexes ($p < 0.05$).

Conclusions: Rates of CTS and cubital tunnel syndrome were markedly higher at older ages, and age-adjusted rates of CTS in women were triple those in men. Rates of both disorders were markedly higher in whites than blacks. Sex and race differences according to occupation did not account for the occupations at highest risk. Further research is needed to determine the extent to which CTS and related disorders could be prevented by modifying the motions currently performed in occupations with the highest SIRs. Additional studies also are needed of other cumulative trauma disorders, such as tenosynovitis and bursitis.

Introduction

Carpal tunnel syndrome (CTS) and other nerve entrapment disorders of the upper extremity have recently received increased attention nationally and within the Navy (1,2). For example, the most recent edition of the Navy Occupational Safety and Health Program Manual now includes a chapter on ergonomics which focuses largely on cumulative trauma and nerve entrapment syndromes (1). In a recent survey of occupational illnesses, the U.S. Department of Labor reported that disorders associated with cumulative trauma (e.g., conditions due to repeated motion, vibration, or pressure) made up about six-tenths of all occupational illnesses reported in 1990 (3).

Carpal tunnel syndrome is the most common nerve entrapment disorder of the upper extremity. It is a neuritis due to cumulative trauma from repeated compression of the median nerve as it passes between the carpal bones and flexor ligaments enroute to the fingers (3-7). Sensory impairments are classically described as occurring in the index and middle fingers and the radial side of the ring finger of the hand predominantly used in work (5). The classic example in case reports is a woman over 40 years of age, with pain and paresthesias in these fingers (5). However, younger individuals of both sexes are increasingly reported with the syndrome (2,6,7).

CTS has been reported in association with jobs involving repetitive flexing or extending of the wrist, vigorous gripping, or vibration (6-11). Numerous occupations have been associated with CTS, including meat processors, farmers, mechanics, garment workers, dentists, surgeons, occupational and physical therapists, carpenters, musicians, janitors, gardeners, and painters (2,4-7,10). Predisposing conditions include pregnancy, diabetes mellitus, rheumatoid arthritis, and thyroid disorders (7,10). Nonhospitalized cases of CTS have been reported to occur most frequently among white, middle-aged women in jobs requiring repetitive hand motions, such as the occupations of keypunch operator and cashier (4).

Hospitalized cases represent the most serious manifestation of the syndrome, and the major reason for hospitalization is surgical decompression of the median nerve (10). It has been estimated that there are more than 5,000 hospitalized cases of CTS in the United States annually (Commission on Professional Activities, Personal Communication, 1992).

Cubital tunnel syndrome is a neuritis of the ulnar nerve which was historically considered largely idiopathic, although occasional case reports suggested a role of occupational factors (9). The syndrome is due to entrapment of the ulnar nerve as it passes into the cubital tunnel at the elbow, enroute to the hand. Symptoms may include numbness, tingling, or coldness in the little and ring fingers (9).

Case reports of cubital tunnel syndrome and ulnar neuritis have been reported in computer keyboard operators and truck drivers who maintain the elbows in flexed positions for long periods; in workers pushing heavy carts where the arms are in prolonged extension; in those using hammers; and in workers using vibrating tools, such as pneumatic drills or hammers, or working with power handsaws (1,8,9). Diabetes mellitus and alcoholism may predispose some individuals to cubital tunnel syndrome (9).

The remaining types of neuritis of the arm and hand are a combination of disorders of uncertain definition and cause. These include unspecified neuritis of the median nerve, neuritis of the radial nerve, causalgia, mononeuritis multiplex, and various unspecified forms of mononeuritis.

The Navy enlisted population is especially well-suited to studies of occupational disorders, since Navy personnel are generally young, and of similar socioeconomic status at the time they enter an occupation. This is a report of incidence rates and occupational risk of first hospitalizations for CTS, cubital tunnel syndrome, and all neuritis of the arm and hand in active-duty enlisted Navy personnel during 1980 to 1988.

Methods

The Naval Health Research Center in San Diego maintains computer-based career and medical history files that include all hospitalizations of active-duty enlisted personnel in all Navy medical facilities, demographic data, and occupational histories covering the entire length of service for each individual. More than 80 enlisted occupations are pursued in the Navy, some of which involve a wide range of repetitive manual tasks. The sources of data used in this study have been resources for previous epidemiological studies and have been described in detail (12,13).

Computerized records of all personnel on active duty from January 1, 1980, through December 31, 1988, were searched for all diagnoses of CTS (ICD-9-CM Code 354.0), neuritis of the median nerve (Code 354.1), cubital tunnel syndrome and other neuritis of the ulnar nerve (Code 354.2), other mononeuritis of the arm and hand (including neuritis of the radial nerve, causalgia, mononeuritis multiplex) (Codes 354.3-354.8), and unspecified mononeuritis of the arm and hand (Code 354.9) (14). Second and later hospitalizations for each diagnosis were excluded in order to provide unduplicated counts; consequently, analyses reflected only first hospitalizations for each disorder.

Age, sex, and race-specific incidence rates of first hospitalization for CTS, cubital tunnel syndrome, and other mononeuritis of the arm and hand were calculated using person-years denominators for the entire period 1980 to 1988. Age-adjusted rates and SIRs were calculated by the indirect method (15), and confidence intervals on the SIRs were computed based on the Poisson distribution (15,16). The incidence rate of first

hospitalization for each diagnosis for the total of all Navy enlisted person-years from 1980 to 1988 was used as the standard, with the following age intervals: 17-19, 20-21, 22-24, 25-29, 30-34, 35-39, 40-44, and 45-61 years. The latter two intervals were collapsed in women, since there were relatively few person-years in women 45 years and older. Specific comparisons between rates were tested for significance using the chi-square test (15).

Results

During the study period, there were 1,039 first hospitalizations for all neuritis of the arm and hand in 4,095,708 person-years at risk in men and 186 in 365,668 person-years at risk in women (Table 1).

Demographic factors

Incidence rates of hospitalized CTS rose with age in both sexes, with a considerably more pronounced effect of age in women (Figure 1). Age-adjusted rates were also higher in women than men ($p < 0.0001$) (Table 1). Rates in white women were about triple those in white men ($p < 0.0001$), but rates in black women were not significantly different from those in black men (Figure 2). Incidence rates of CTS were significantly higher in whites than blacks ($p < 0.05$), mainly due to the higher rates in white women ($p < 0.01$) (Figure 2).

Incidence rates of cubital tunnel syndrome also increased with age ($p < 0.001$), especially in women (Figure 3). Age-adjusted rates in women were about one and one-half times those of men ($p < 0.02$). Incidence rates were higher in whites ($p < 0.05$), primarily due to higher rates in white women ($p < 0.05$) (Figure 4). Female predominance of the disorder was limited to whites.

There was a marked and steady increase with age in incidence rates of first hospitalization for all neuritis of the arm and hand in both sexes ($p < 0.001$), with a particularly strong effect of age in women (Table 1). Age-adjusted incidence rates of all neuritis of the arm and hand in women were about twice as high as in men ($p < 0.01$).

Occupation

Occupations with significantly high SIRs for CTS in men included aviation support equipment technician, engineman, hull maintenance technician, boatswain's mate, and machinist's mate (Table 2). Occupations with high SIRs in women included boatswain's

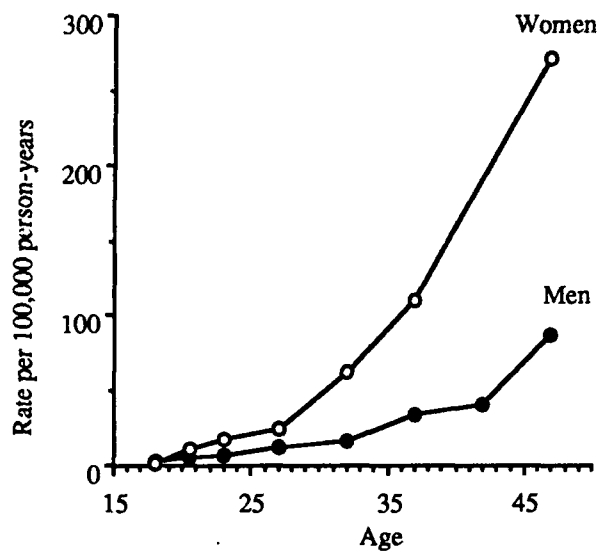


Figure 1. Incidence rates of first hospitalization for carpal tunnel syndrome, by age, active-duty Navy enlisted personnel, 1980 to 1988

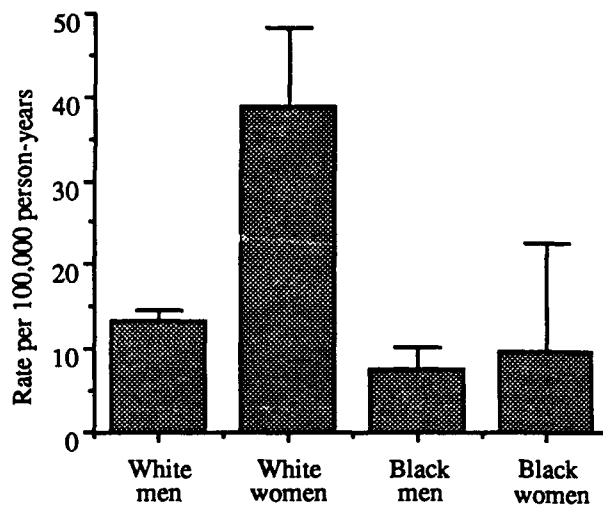


Figure 2. Age-adjusted incidence rates and 95 percent confidence intervals for first hospitalization for carpal tunnel syndrome, active-duty Navy enlisted personnel, 1980 to 1988

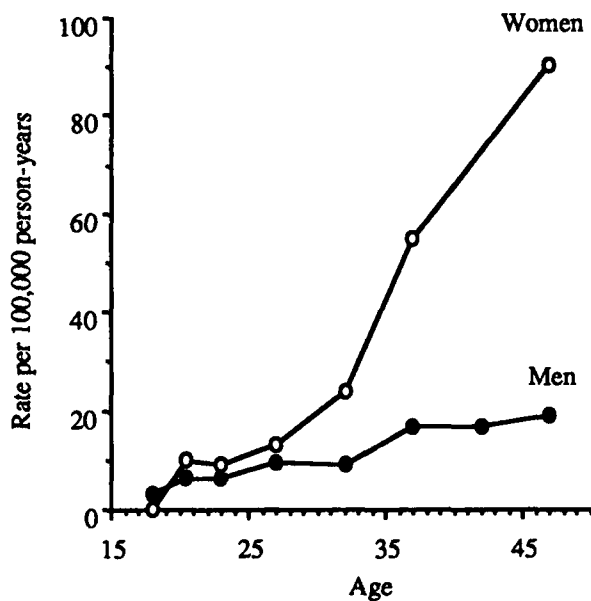


Figure 3. Incidence rates of first hospitalization for cubital tunnel syndrome, by age, active-duty Navy enlisted personnel, 1980 to 1988

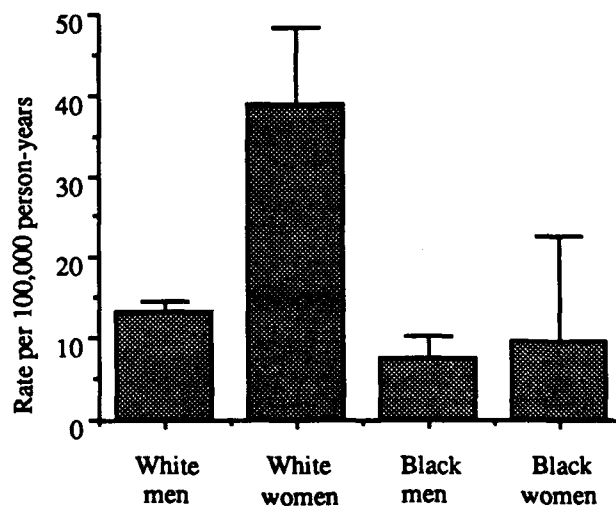


Figure 2. Age-adjusted incidence rates and 95 percent confidence intervals for first hospitalization for carpal tunnel syndrome, active-duty Navy enlisted personnel, 1980 to 1988

mate, engineman, hospital corpsman, ocean systems technician, and personnelman (Table 3). The occupations of boatswain's mate and engineman had high SIRs in both sexes.

Occupations with significantly high SIRs for cubital tunnel syndrome in men included boatswain's mate, hospital corpsman, and boiler technician (Table 2). Occupations with significantly high SIRs for cubital tunnel syndrome in women included hospital corpsman, aviation electronics technician, data processing technician, and builder (Table 3). Hospital corpsmen of both sexes had high SIRs for cubital tunnel syndrome.

For all types of neuritis of the hand and arm combined in men, the occupations of engineman, hull maintenance technician, boatswain's mate, machinist's mate, and seaman significantly had high SIRs. Occupations with significantly high SIRs in women included operations specialist, boatswain's mate, illustrator-draftsman, engineman, hospital corpsman, ocean systems technician, hull maintenance technician, aviation electronics technician, personnelman, and builder.

In a race-specific comparison of incidence rates of CTS in the eight occupations at highest risk for the disorder in either sex, women had higher age-adjusted rates than men in seven; although only two of the relative risks, those for hospital corpsman and personnelman, were statistically significant (Table 4). The relative risk associated with being female was 5.2 ($p < 0.001$) in the occupation of hospital corpsman and 5.1 in the occupation of personnelman ($p < 0.05$). For the total of all eight high-risk occupations, the relative risk associated with being female was 3.4 ($p < 0.001$). The analysis was limited to whites, since sample size limitations precluded similar comparisons within other racial groups.

In an effort to determine if women were over-represented in the highest-risk occupations for CTS, an analysis was done of the number of person-years contributed by women to these occupations (Table 5). Women were over-represented in some occupations, such as ocean systems technician (for which 35 percent of person-years at risk were contributed by women), but under represented in others, such as machinist's mate (for which less than 1 percent of person-years were contributed by women). The overall contribution of women to person-years at risk in high-risk occupations (8 percent) was the same as the contribution by women to all person-years at risk in the entire Navy. A similar analysis by race showed that the contribution of black men to person-years in high-risk occupations (12 percent of person-years) was similar to the contribution of black men to all person-years in the Navy (14 percent), and the contribution of black women to person-years in high-risk occupations (15 percent) was slightly less than that in the entire Navy (20 percent) (not shown). (Detailed age-race-sex-occupation and diagnosis-specific tables are available from the authors on request.)

Discussion

First hospitalization rates for CTS and cubital tunnel syndrome were strongly related to age, sex, and race. Rates of both disorders were markedly higher at older ages and age-adjusted rates of CTS in women were approximately triple those in men. Rates of both disorders were markedly higher in white than black women.

Occupational factors

Carpal tunnel syndrome. There was considerable occupational variation in SIRs for CTS. Aviation support equipment technicians, skilled mechanics who maintain engines and other systems on vehicles used to transport and service aircraft at airports and on aircraft carriers, had the highest SIR in men. These workers routinely perform tasks requiring vigorous and forceful use of the hands. Enginemen, who had the next highest SIR, maintain automobiles, trucks, internal combustion engines aboard vessels, and stationary reciprocating engines, and perform many tasks similar to those of civilian automotive mechanics.

Hull maintenance technicians, who maintain the integrity of the ship's structure, had an SIR similar to enginemen. These workers also perform tasks requiring forceful movements of the arms and hands. Boatswain's mates, who had a high SIR, clean, scrape, paint, and maintain surfaces on ships, and perform a wide range of other maintenance activities. The repetitive motions required in these activities could cause small but cumulative injuries. Some Navy painting tasks are performed using spray painting equipment, but most painting done by boatswain's mates involves manual application. Machinist's mates, who also had a high SIR, grind and shape metal parts needed for shipboard operations. Like other occupations with high SIRs for CTS, their activities require repetitive movements of the arms and hands.

The highest SIRs for CTS in women were the occupations of boatswain's mate, hospital corpsman, engineman, ocean systems technician, and personnelman. Women in these occupations perform duties generally similar to men in the occupation.

Hospital corpsmen carry out a range of nursing-related tasks requiring forceful movements of the hands. The nature of these tasks is consistent with the possibility of cumulative injuries to nerves of the wrist, hand, and arm, although an enhanced sensitivity to these conditions and the greater immediate accessibility of medical care may also have been a contributing factors to the high rates in this occupation.

The tasks performed by personnelmen are similar to those of civilian data-entry clerks and interviewers. Ocean systems technicians perform keyboard data-entry tasks and make detailed pencil annotations on charts on flat or slightly inclined surfaces. While personnelmen and ocean systems technicians generally do not perform forceful or vigorous motions of the arm, the hand motions involved in their activities are extremely repetitive.

The higher incidence rates of hospitalized CTS in women could not be accounted for by the differential selection of high-risk occupations by women. While women were numerically over-represented in some high-risk occupations, they were under represented in others. This tended to cancel out any effect of differential selection. The only high-risk occupation in which a female excess was not either statistically significant or in the direction of increased risk was that of machinist's mate, which had relatively few female person-years at risk. These findings suggest that the excess risk of hospitalized CTS in women was a general difference between the sexes in risk of developing (or being diagnosed with) the disorder to a degree serious enough to warrant hospitalization, rather than a result of assignment of women to high-risk occupations.

Although nerve entrapment syndromes have been previously reported to be associated with occupation (2, 10), the contribution of ergonomic factors to these disorders has been questioned. A study which tested nerve conduction -- which is the most unequivocal test for diagnosis of nerve entrapment syndromes -- evaluated 471 subjects in five groups categorized from low to high risk of CTS, and failed to find an association with workplace exposure (17). Another study demonstrated widely varying incidence rates in geographically different locations with roughly identical workplace conditions, and concluded that job and personal satisfaction should be considered as confounders when CTS is diagnosed in the workplace (18).

In the Navy, medical care is provided and disability benefits awarded regardless of whether the service member's work is implicated. This may differ from settings in which the likelihood of work-related diagnoses might be influenced by compensation (19). Work-relatedness was assumed in this study. Because Navy enlisted personnel are free of known illnesses at entry to the Navy, are relatively young, are of similar socioeconomic status, and use the same medical care system for all diagnosis and treatment, extraneous sources of variation in incidence rates may be fewer than would be encountered in the general population. The results of this study strongly suggest an occupational component to the most severe forms of upper extremity nerve entrapment syndromes and neuritis.

In the general population, nerve entrapment syndromes and neuritis have been reported to be a relatively small proportion of all cumulative trauma disorders of the upper extremity. A study describing the spectrum of conditions meeting the case definitions for cumulative trauma disorders during a five-year period for workers in the state of Ohio reported 6,849 cases of cumulative trauma disorders, of which only 166 (2.4 percent)

were upper extremity neuritis of all types; 114 were CTS (20). The most common cumulative trauma disorders included 2,687 cases (39.2 percent) of tenosynovitis disorders involving the wrist – such as de Quervain's tenosynovitis of the thumb extensor tendon and tenosynovitis/bursitis syndromes involving the elbow; and 405 cases (5.9 percent) of tennis elbow.

The incidence rates in this study of first hospitalization for all neuritis of the arm and hand of 25.4 per 100,000 person-years in men and 50.9 per 100,000 person-years women may not be high enough to warrant active surveillance. This would be true even if the above rates – which actually reflect long-term cases that are severe enough to require surgery after a trial of conservative management has failed — reflected only 50 percent of the true annual incidence of these disorders.

Recently, the Navy has required education of supervisors and workers when repetitive motion conditions exist; a workplace evaluation checklist has been developed to confirm whether education and consideration of workplace modification following professional evaluation should occur (1). These recommendations are binding only on shore commands, which, for the most part, are staffed by civilians. The results of this study suggest that such a program should also be instituted for operating Navy and Marine forces.

As of 1990, 10 states were cooperating with the National Institute for Occupational Safety and Health (NIOSH) in the Sentinel Event Notification System for Occupational Risks (SENSOR)(21). These states designated up to six occupational conditions for mandatory reporting by licensed medical practitioners in a manner similar to that required for many infectious diseases. These conditions are: lead poisoning, noise-induced hearing loss, occupational asthma, pesticide poisoning, CTS, and silicosis. Surveillance case definitions for work-related CTS have been described (22). Such a reporting system could be useful for the Navy for CTS.

Further studies are needed of ergonomic factors (23) in the occupations with the highest SIRs. Repetitive or unusually forceful use of the wrist, hand, or arm may be common to these occupations. More research is needed to determine the extent to which neuritis of the arm and hand could be prevented by modifying the motions currently performed in the occupations with the highest SIRs.

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Table 1. Incidence rates of first hospitalization for carpal tunnel syndrome, cubital tunnel syndrome, and other neuritis of the arm and hand, per 100,000 person-years, active-duty Navy enlisted personnel, 1980 to 1988

Age in years	No. of person-years at risk	Carpal tunnel syndrome (ICD 354.0)				Cubital tunnel syndrome (ICD 354.2)				Other neuritis of the arm and hand (ICD 354.1, 354.3-9)				All neuritis of the arm and hand (ICD 354.0-9)			
		No. of cases	Rate	95 Percent confidence interval		No. of cases	Rate	95 Percent confidence interval		No. of cases	Rate	95 Percent confidence interval		No. of cases	Rate	95 Percent confidence interval	
				Lower	Upper			Lower	Upper			Lower	Upper			Lower	Upper
Men																	
17-19	663,739	18	2.7	1.6	4.3	22	3.3	2.1	5.0	30	4.5	3.1	6.5	70	10.5	8.3	13.4
20-21	801,304	43	5.4	3.9	7.2	49	6.1	4.5	8.1	53	6.6	4.9	8.7	145	18.1	15.3	21.4
22-24	867,520	62	7.1	5.5	9.3	56	6.5	5.0	8.4	52	6.0	4.4	7.9	170	19.6	16.7	22.9
25-29	796,444	95	11.9	9.6	14.8	76	9.5	7.6	11.9	43	5.4	3.9	7.3	214	26.9	23.3	30.9
30-34	476,938	79	16.6	13.2	20.7	43	9.0	6.6	12.1	21	4.4	2.7	6.7	143	30.0	25.3	35.5
35-39	332,471	118	35.5	29.6	42.6	55	16.5	12.3	21.8	7	2.1	0.8	4.3	180	54.1	46.7	62.8
40-44	120,245	45	37.4	27.3	50.1	20	16.6	10.2	25.6	7	5.8	2.3	12.0	72	59.9	47.0	76.0
45-61	37,047	33	89.1	62.1	127.4	7	18.9	7.6	38.9	5	13.5	4.4	31.4	45	121.5	88.5	162.8
Total	4,095,708	493	12.0	11.0	13.2	328	8.0	7.2	8.9	218	5.3	4.6	6.1	1,039	25.4	23.8	27.0
Age-adjusted rate			11.8	10.8	12.9		7.9	7.1	8.8		5.3	4.6	6.1		25.1	23.5	26.7
Women																	
17-19	57,087	1	1.8	0.0	9.8	0	0.0	0.0	5.3	2	3.5	0.4	12.6	3	5.3	1.1	15.3
20-21	79,854	9	11.3	5.2	21.4	8	10.0	4.3	19.7	7	8.8	3.5	18.1	24	30.1	19.3	44.8
22-24	98,889	18	18.2	10.6	28.8	9	9.1	4.2	17.3	7	7.1	2.8	14.6	34	34.4	24.0	47.8
25-29	84,782	22	25.9	16.1	39.2	11	13.0	6.5	23.2	18	21.2	12.6	33.5	51	60.2	44.6	79.4
30-34	33,750	24	71.1	44.0	106.0	8	23.7	10.2	46.7	14	41.5	22.6	69.7	46	136.3	99.4	182.6
35-39	9,101	10	109.9	52.7	202.2	5	54.9	17.8	128.0	5	54.9	17.8	128.0	20	219.8	134.3	338.4
40-61	2,205	6	272.1	99.9	593.2	2	90.7	11.0	327.4	0	0.0	0.0	136.1	8	362.8	156.4	714.7
Total	365,668	90	24.6	19.9	30.5	43	11.8	8.6	15.8	53	14.5	10.8	19.1	186	50.9	43.8	59.0
Age-adjusted rate			31.8	25.7	39.4		13.1	9.6	17.6		14.3	10.6	18.8		58.7	50.6	68.1

Table 2. Standardized incidence ratios, carpal tunnel syndrome, cubital tunnel syndrome, and all neuritis of the arm and hand, in order of magnitude of SIR, active-duty Navy enlisted men, 1980 to 1988

Occupation	Person-years at risk	Carpal tunnel syndrome		Cubital tunnel syndrome		All neuritis ‡	
		Number of cases	SIR	Number of cases	SIR	Number of cases	SIR
Aviation Support Equipment Technician (AS)	21,529	9	2.60 *	1	0.49	11	1.67
Gas Turbine System Technician (GS)	21,617	6	2.10	1	0.54	7	1.20
Engineman (EN)	76,743	21	1.96 *	9	1.35	40	1.87 *
Hull Maintenance Technician (HT)	104,612	27	1.90 *	14	1.56	48	1.67 *
Molder (ML)	3,231	2	1.87	0	0.00	2	1.98
Illustrator Draftsman (DM)	2,503	1	1.83	0	0.00	1	1.05
Boatswain's Mate (BM)	87,740	27	1.73 *	18	2.03 *	51	1.76 *
Machinery Repairman (MR)	23,805	6	1.60	2	0.90	8	1.11
Signalman (SM)	28,466	6	1.55	2	0.83	8	1.03
Data Processing Technician (DP)	24,616	6	1.48	2	0.85	8	1.04
Musician (MU)	6,255	2	1.43	1	1.40	3	1.24
Machinist's Mate (MM)	250,690	42	1.40 *	24	1.18	84	1.31 *
Electronics Warfare Technician (ET)	23,344	4	1.35	4	2.04	7	1.14
Legalman (LN)	2,898	1	1.33	1	2.70	2	1.60
Equipmentman (EQ)	18,914	4	1.28	3	1.75	9	1.53
Instrumentman (IM)	4,727	1	1.28	0	0.00	1	0.68
Dental Technician (DT)	21,273	4	1.25	1	0.52	5	0.80
Seaman (SN)	406,043	28	1.23	29	1.35	90	1.37 *
Hospital Corpsman (HM)	185,785	33	1.22	27	1.63 *	66	1.24
Interior Communication Electrician (IC)	50,848	8	1.22	3	0.69	13	0.96
Aviation Structural Mechanic (AM)	146,194	24	1.14	10	0.77	41	0.98
Ocean Systems Technician (OT)	10,083	1	1.12	0	0.00	1	0.60
Airman (AN)	175,802	10	1.04	4	0.43	25	0.89
Boiler Technician (BT)	98,874	13	1.02	17	2.03 *	35	1.32
Builder (BU)	25,627	4	1.01	4	1.76	10	1.31
Gunner's Mate (GM)	66,672	10	0.99	8	1.32	19	0.97
Electrician's Mate (EM)	121,826	16	0.98	13	1.24	42	1.26
Missile Technician (MT)	17,466	2	0.93	1	0.68	3	0.66
Mess Management Specialist (MS)	147,436	27	0.92	10	0.65	44	0.84
Sonar Technician (ST)	74,568	8	0.90	5	0.83	18	0.95
Air Controlman (AC)	20,392	3	0.90	2	1.03	6	0.95
Ship's Serviceman (SH)	43,864	7	0.89	1	0.23	11	0.76
Quartermaster (QM)	39,560	5	0.87	3	0.86	10	0.89
Data Systems Technician (DS)	25,402	3	0.84	4	1.74	8	1.11
Personnelman (PN)	51,921	8	0.81	4	0.75	12	0.67
Electronics Technician (ET)	163,024	17	0.79	9	0.64	32	0.72
Torpedoman's Mate (TM)	34,432	4	0.79	3	0.97	9	0.90
Aviation Ordnanceman (AO)	86,885	6	0.76	6	1.19	19	1.18
Steelworker (SW)	9,093	1	0.74	1	1.26	2	0.76
Navy Counselor (NC)	12,395	3	0.71	2	1.10	5	0.76
Postal Clerk (PC)	9,165	1	0.68	1	1.15	3	1.07
Aviation Electrician's Mate (AE)	73,391	7	0.65	3	0.45	17	0.80
Communications Technician (CT)	74,724	8	0.64	3	0.41	12	0.51 †
Fireman Apprentice (FN)	176,726	6	0.64	8	0.88	19	0.68
Aviation Machinist's Mate (AD)	108,169	10	0.60	5	0.50	22	0.68
Aircraft Maintenance Technician (AF)	2,973	1	0.59	0	0.00	2	0.81
Operations Specialist (OS)	92,194	6	0.54	9	1.22	18	0.77
Fire Control Technician (FT)	54,179	4	0.53	6	1.26	14	0.92
Aerographer's Mate (AG)	10,958	1	0.53	0	0.00	1	0.28
Construction Electrician (CE)	12,939	1	0.48	1	0.85	3	0.76
Storekeeper (SK)	79,386	7	0.47 †	4	0.49	16	0.59 †
Aviation Storekeeper (AK)	37,034	2	0.47	0	0.00	3	0.25 †
Aviation Electronics Technician (AT)	99,112	7	0.46 †	8	0.87	21	0.71

Table 2. — Continued — Standardized incidence ratios, carpal tunnel syndrome, cubital tunnel syndrome, and all neuritis of the arm and hand, in order of magnitude of SIR, active-duty Navy enlisted men, 1980 to 1988

Occupation	Person-years at risk	Carpal tunnel syndrome		Cubital tunnel syndrome		All neuritis ‡	
		Number of cases	SIR	Number of cases	SIR	Number of cases	SIR
Aviation Antisubmarine Warfare Operator (AV)	30,276	2	0.46	2	0.73	4	0.46
Aviation Maintenance Administrationman (AZ)	26,747	3	0.45	2	0.78	3	0.36
Yeoman (YN)	82,846	6	0.39 †	4	0.48	15	0.54 †
Aircrew Survival Equipmentman (PR)	17,527	1	0.38	3	1.87	5	0.97
Aviation Antisubmarine Warfare Technician (A)	18,318	1	0.36	0	0.00	4	0.74
Master-At-Arms (MA)	12,089	1	0.27	2	1.17	5	0.84
Radioman (RM)	128,085	5	0.26 †	12	1.04	21	0.56 †
Aviation Boatswain's Mate (AB)	60,364	2	0.25 †	1	0.19	6	0.37 †
Disbursing Clerk (DK)	20,794	1	0.25	1	0.47	2	0.28
Fire Controlman (FC)	29,118	0	0.00	0	0.00	0	0.00
Photographer's Mate (PH)	14,797	0	0.00	2	1.45	2	0.45
Construction Mechanic (CM)	14,575	0	0.00	0	0.00	1	0.23
Utilities Man (UT)	12,002	0	0.00	1	0.91	1	0.27
Intelligence Specialist (IS)	10,262	0	0.00	0	0.00	1	0.33
Tradesman (TD)	9,401	0	0.00	0	0.00	1	0.32
Journalist (JO)	6,215	0	0.00	1	1.52	1	0.45
Construction Man (CN)	5,464	0	0.00	0	0.00	0	0.00
Religious Program (RP)	5,361	0	0.00	0	0.00	0	0.00
Mineman (MN)	4,912	0	0.00	0	0.00	0	0.00
Lithographer (LI)	3,665	0	0.00	0	0.00	0	0.00
Engineering Aide (EA)	3,088	0	0.00	0	0.00	0	0.00
Weapons Technician (WT)	3,043	0	0.00	0	0.00	0	0.00
Opticalman (OM)	2,880	0	0.00	0	0.00	0	0.00
Damage Controlman (DC)	2,804	0	0.00	0	0.00	0	0.00
Avionics Technician (AV)	2,523	0	0.00	0	0.00	0	0.00
Constructionman (CN)	335	0	0.00	0	0.00	0	0.00
Utilities Constructionman (UCC)	65	0	0.00	0	0.00	0	0.00
Precision Instrumentman (PI)	47	0	0.00	0	0.00	0	0.00
Total men	4,095,708	493		328		1,039	

* Significantly high at the $p \leq 0.05$ level

† Significantly low at the $p \leq 0.05$ level

‡ Includes other neuritis of the arm and hand

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Table 3. Standardized incidence ratios, carpal tunnel syndrome, cubital tunnel syndrome, and all neuritis of the arm and hand, in order of magnitude of SIR, active-duty Navy enlisted women, 1980 to 1988 ‡

Occupation	Person-years at risk	Carpal tunnel syndrome		Cubital tunnel syndrome		All neuritis ¶	
		Number of cases	SIR	Number of cases	SIR	Number of cases	SIR
Utilities Man (UT)	372	1	28.08	0	0.00	1	11.89
Signalman (SM)	639	1	19.38	0	0.00	1	7.69
Operations Specialist (OS)	459	1	17.52	1	25.95	5	41.57 *
Aviation Antisubmarine Warfare Technician (A)	814	1	10.55	0	0.00	1	4.83
Boatswain's Mate (BM)	2,747	3	9.82 *	0	0.00	4	5.91 *
Illustrator Draftsman (DM)	728	1	9.61	0	0.00	2	9.52 *
Engineman (EN)	4,151	3	8.20 *	0	0.00	5	5.60 *
Machinery Repairman (MR)	1,546	1	6.74	0	0.00	2	5.77
Hospital Corpsman (HM)	38,393	27	6.34 *	11	3.61 *	55	5.84 *
Ocean Systems Technician (OT)	5,505	3	5.59 *	1	6.03	5	9.92 *
Hull Maintenance Technician (HT)	3,938	2	5.15	0	0.00	4	4.44 *
Aviation Support Equipment Technician (AS)	1,836	1	5.09	0	0.00	1	2.26
Journalist (JO)	1,488	1	4.71	0	0.00	1	2.34
Torpedoman's Mate (TM)	2,634	1	4.48	0	0.00	1	1.81
Aviation Electronics Technician (AT)	3,614	2	4.19	3	9.41 *	6	6.05 *
Personnelman (PN)	15,135	8	4.15 *	4	3.10	16	3.96 *
Electronics Technician (ET)	6,847	3	3.65	0	0.00	3	1.69
Ship's Serviceman (SH)	2,711	1	3.53	0	0.00	2	3.12
Mess Management Specialist (MS)	11,442	4	3.49	0	0.00	5	1.89
Dental Technician (DT)	9,978	3	2.97	2	2.66	6	2.59
Photographer's Mate (PH)	2,623	1	2.72	0	0.00	1	1.35
Disbursing Clerk (DK)	3,790	1	2.20	0	0.00	2	2.04
Aviation Storekeeper (AK)	7,830	2	2.18	0	0.00	3	1.50
Aviation Machinist's Mate (AD)	4,978	1	2.02	0	0.00	1	0.87
Storekeeper (SK)	8,711	2	1.81	2	2.71	4	1.73
Seaman (SN)	56,965	6	1.65	3	0.91	16	1.60
Air Controlman (AC)	5,948	1	1.63	0	0.00	1	0.71
Aviation Maintenance Administrationman (AZ)	6,357	1	1.34	0	0.00	1	0.62
Airman (AN)	20,635	1	0.77	1	0.85	3	0.84
Yeoman (YN)	30,266	3	0.75	3	1.15	7	0.85
Data Processing Technician (DP)	12,349	1	0.70	4	3.98 *	6	1.93
Communications Technician (CT)	17,693	1	0.55	1	0.74	4	0.96
Radioman (RM)	25,927	1	0.38	1	0.51	3	0.50
Fireman Apprentice (FN)	9,383	0	0.00	1	1.91	2	1.25
Aviation Structural Mechanic (AM)	4,722	0	0.00	1	2.80	1	0.91
Aerographer's Mate (AG)	3,664	0	0.00	1	3.35	1	1.08
Electrician's Mate (EM)	3,098	0	0.00	0	0.00	0	0.00
Tradesman (TD)	2,368	0	0.00	0	0.00	0	0.00
Interior Communication Electrician (IC)	2,319	0	0.00	0	0.00	0	0.00
Aircrew Survival Equipmentman (PR)	2,031	0	0.00	0	0.00	0	0.00
Aviation Electrician's Mate (AE)	1,838	0	0.00	0	0.00	0	0.00
Religious Program (RP)	1,794	0	0.00	0	0.00	0	0.00
Intelligence Specialist (IS)	1,462	0	0.00	0	0.00	0	0.00
Postal Clerk (PC)	1,344	0	0.00	0	0.00	0	0.00
Aviation Boatswain's Mate (AB)	1,249	0	0.00	0	0.00	0	0.00
Legalman (LN)	1,103	0	0.00	0	0.00	0	0.00
Quartermaster (QM)	955	0	0.00	0	0.00	0	0.00
Master-At-Arms (MA)	951	0	0.00	1	9.38	2	5.68
Data Systems Technician (DS)	873	0	0.00	0	0.00	0	0.00
Navy Counselor (NC)	672	0	0.00	0	0.00	0	0.00
Aviation Ordnanceman (AO)	626	0	0.00	0	0.00	0	0.00
Instrumentman (IM)	607	0	0.00	0	0.00	0	0.00
Musician (MU)	562	0	0.00	0	0.00	0	0.00
Builder (BU)	548	0	0.00	2	47.06 *	2	15.33 *

Table 3. — *Continued* —Standardized incidence ratios, carpal tunnel syndrome, cubital tunnel syndrome, and all neuritis of the arm and hand, in order of magnitude of SIR, active-duty Navy enlisted women, 1980 to 1988

Occupation	Person-years at risk	Carpal tunnel syndrome		Cubital tunnel syndrome		All neuritis ‡	
		Number of cases	SIR	Number of cases	SIR	Number of cases	SIR
Gunner's Mate (GM)	477	0	0.00	0	0.00	0	0.00
Equipmentman (EQ)	472	0	0.00	0	0.00	0	0.00
Mineman (MN)	441	0	0.00	0	0.00	0	0.00
Machinist's Mate (MM)	411	0	0.00	0	0.00	0	0.00
Opticalman (OM)	404	0	0.00	0	0.00	0	0.00
Construction Mechanic (CM)	361	0	0.00	0	0.00	0	0.00
Construction Electrician (CE)	320	0	0.00	0	0.00	0	0.00
Lithographer (LI)	289	0	0.00	0	0.00	0	0.00
Construction Man (CN)	252	0	0.00	0	0.00	0	0.00
Steelworker (SW)	188	0	0.00	0	0.00	0	0.00
Molder (ML)	172	0	0.00	0	0.00	0	0.00
Engineering Aide (EA)	172	0	0.00	0	0.00	0	0.00
Weapons Technician (WT)	165	0	0.00	0	0.00	0	0.00
Damage Controlman (DC)	115	0	0.00	0	0.00	0	0.00
Boiler Technician (BT)	76	0	0.00	0	0.00	0	0.00
Fire Control Technician (FT)	73	0	0.00	0	0.00	0	0.00
Fire Controlman (FC)	62	0	0.00	0	0.00	0	0.00
Total women	365,668	90		43		186	

* Significantly high at the $p \leq 0.05$ level

† Significantly low at the $p \leq 0.05$ level

‡ There were no women in the following occupations:

Electronics Warfare Technician (ET)
Sonar Technician (ST)
Missile Technician (MT)
Precision Instrumentman (PI)
Gas Turbine System Technician (GS)
Constructionman (CN)
Utilities Constructionman (UCC)
Aircraft Maintenance Technician (AF)
Avionics Technician (AV)
Aviation Antisubmarine Warfare Operator (AW)

¶ Includes other neuritis of the arm and hand

Table 4. Occupations with significantly high age-adjusted incidence rates of carpal tunnel syndrome, in order of female to male ratio, of age-adjusted rates, active-duty Navy enlisted personnel, whites, 1980 to 1988

Occupation	Men				Women				Ratio of female to male age-adjusted rates
	No. of cases	Person-years at risk	Crude rate per 100,000	Age-adjusted rate per 100,000	No. of cases	Person-years at risk	Crude rate per 100,000	Age-adjusted rate per 100,000	
Boatswain's Mate	27	87,740	30.8	22.6	3	2,747	109.2	128.3	5.7
Hospital Corpsman	33	185,785	17.8	15.9	27	38,393	70.3	82.9	5.2***
Personnelman	8	51,921	15.4	10.6	8	15,135	52.9	54.2	5.1*
Ocean Systems Technician	1	10,083	9.9	14.6	3	5,505	54.5	73.1	5.0
Engineman	21	76,743	27.4	25.6	3	4,151	72.3	107.2	4.2
Hull Maintenance Technician	27	104,612	25.8	24.8	2	3,938	50.8	67.3	2.7
Aviation Support Equipment Technician	9	21,529	41.8	34.0	1	1,836	54.5	66.5	2.0
Machinist's Mate	42	250,690	16.8	18.3	0	411	0.0	0.0	0.0
Total	168	789,103	21.3	20.4	47	72,116	65.2	70.2	3.4***
All Navy enlisted personnel, whites	438	3,289,893	13.3	13.3	85	280,418	30.3	38.7	2.9***

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 5. Person-years at risk in each of the eight highest-risk occupations for carpal tunnel syndrome, active-duty Navy enlisted personnel, whites, 1980 to 1988

Occupation	Person-years at risk, men	Person-years at risk, women	Percent of of person- years contributed by women
Aviation Support Equipment Technician	21,529	1,836	8
Boatswain's Mate	87,740	2,747	3
Engineman	76,743	4,151	5
Hospital Corpsman	185,785	38,393	17
Hull Maintenance Technician	104,612	3,938	4
Machinist's Mate	250,690	411	0
Ocean Systems Technician	10,083	5,505	35
Personnelman	51,921	15,135	23
Total	789,103	72,116	8
All Navy enlisted personnel, whites	3,289,893	280,418	8

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13. ABSTRACT (Maximum 200 words) The majority of reported occupational illnesses in the United States are cumulative trauma disorders of the arm and hand due to repeated motion, vibration, or pressure; among these is carpal tunnel syndrome (CTS). The objectives of this study were to describe demographic factors associated with high rates of CTS and other nerve entrapment disorders and to identify high-risk Navy occupations. Computerized records of first hospitalizations of all Navy enlisted personnel for CTS and other nerve entrapment disorders (ICD-9-CM codes 354.0-354.9) were identified during 1980 to 1988. Age-, sex-, and race-specific incidence rates and age-standardized incidence rates were calculated. There were 493 first hospitalizations for CTS in 4,095,708 person-years in men and 90 in 365,668 person-years in women. Rates of CTS rose with age in both sexes. Rates in white women were about triple those in white men, but rates in black women were not significantly different from black men. In men, occupations with significantly high standardized incidence ratios (SIRs) for CTS included aviation support equipment technician, engineman, hull maintenance technician, boatswain's mate, and machinist's mate. In women they included boatswain's mate, engineman, hospital corpsman, ocean systems technician, and personnelman. Sex and race differences did not account for the occupations at highest risk.				
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